

equal in length. Thorax with its sides obliquely diverging from the base to beyond the middle, thence rounded and converging to the apex, the latter abruptly constricted.

Cephalodonta Haroldi.

Cuneiformis, subdepressa, nitida, subtus nigra, thoracis lateribus, femoribus tibiisque rufo-fulvis; supra læte rufo-fulva, antennis nigris, articulis rufo variegatis; thorace subquadrato, lateribus obsolete angulatis, angulis anticis antrorsum productis; disco transversim convexo, ante basin transversim depresso, profunde foveolato-punctato; elytris a basi apicem versus leviter ampliatis, apice obtusis, leviter serratulis, angulo postico distincto, profunde foveolato-punctatis, punctis striatim dispositis, hic illic confusis, interspatiis ad latera et ad apicem elevato-vittatis, hic illic irregulariter verrucosis.

Long. $3\frac{1}{4}$ – $3\frac{3}{4}$ lin.

Hab. Columbia, river Magdalena.

Nearly allied to *C. tarsata*, at once known by the coarser punctuation and by the irregular surface of the elytra.

VI.—On the Minute Structure of the Corals of the Genera *Heliophyllum* and *Crepidophyllum*. By H. ALLEYNE NICHOLSON, M.D., D.Sc., F.L.S., Professor of Natural History in the University of St. Andrews.

Genus HELIOPHYLLUM*.

Heliophyllum, Hall, in Dana's 'Zoophytes,' Explor. Exped. vol. viii. p. 356, fig. 3, 1846.

Gen. char. Corallum simple or compound, usually turbinate, cono-cylindrical or cylindrical, rarely massive. Increase, in the simple forms, by simple calicular gemmation. Epitheca complete, thin, with encircling striæ and annulations of growth. Tabulæ not complete, but confined to a more or less extensively developed central area. Septa well developed, of two orders, a greater or less number of the primary septa almost always passing inwards to the centre of the visceral chamber, where they become flexuous and unite with one another in an irregular network. In cross section the septa are invariably crossed by conspicuous cross bars or denticulations.

* Descriptions of the characters of *Heliophyllum* and *Crepidophyllum* formed part of a paper, by Mr. James Thomson and myself, which was laid before the Royal Society of Edinburgh in the session 1875–76, and an abstract of which was published in the 'Proceedings,' vol. ix. No. 95, p. 149.

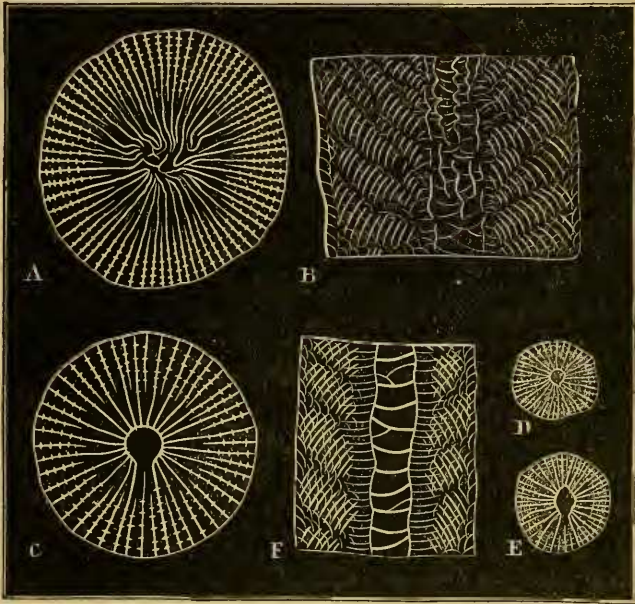
An external vesicular area feebly developed and often almost absent. Dissepiments of two orders :—those of the *first order* very strongly marked, and forming a series of strong ascending ridges, which run inwards and upwards in an arching manner, forming the cross bars on the septa as seen in transverse sections, and appearing on the free edges of the septa in the calice as so many spines or teeth ; those of the *second order* being more delicate, and running in an arched manner inwards and downwards, often producing a greater or less amount of vesicular tissue in the exterior zone. No true columella is present ; but those of the primary septa which reach the centre are often elevated to form a small eminence in the bottom of the cup.

In the typical species of *Heliophyllum* the corallum is essentially simple, and is usually more or less turbinate and conical in form, as in *H. Halli*, Edw. & H. ; *H. canadense*, Bill. ; *H. colbornense*, Nich. ; and *H. elegantulum*, Nich. & Thoms. These primarily simple forms, however, very commonly produce buds by simple calicular gemmation (see a paper by the writer, Trans. Royal Soc. Edinb. vol. xxvii. p. 238), or by what Lindström has termed “ uniserial gemmation.” In these cases the polype, originally and essentially simple, sends up from its oral disk a *single* bud. The primitive calice may or may not be obliterated by the gradual growth and extension of the epitheca over it ; and the secondary calice may or may not produce a tertiary bud in the same manner as that in which it was itself produced. Sometimes the process stops with the production of one or two buds ; at other times it goes on by fits and starts, by periodic restrictions of growth and efforts at reproduction, till the corallum assumes the form of a series of short turbinate cups or inverted cones, superimposed upon one another in the same longitudinal axis, the younger upon the older. There are also not wanting instances, within the limits of the genus *Heliophyllum*, in which the old corallite throws out two, three, or more buds from its oral disk ; though this process is never carried so far as to produce large compound masses. Finally, in one form at present referred to *Heliophyllum* (viz. *H. colligatum*, Bill.) the corallum is truly and essentially compound, forming large fasciculate masses of cylindrical and closely approximated corallites.

The epitheca is complete, usually thin, and marked with numerous delicate encircling lines, generally along with well-marked accretion-ridges.

The form of the calice varies. It is rarely of any great depth, as compared with the proportional bulk of the coral-

lum ; and its floor may be flat, or may exhibit a small rounded eminence formed by the primary septa. The principal feature of importance presented by the calice is, that the free edges of the septa are invariably furnished with prominent spines, formed by the terminations of the ascending dissepiments.



A, cross section of *Heliophyllum Halli*, E. & H., of the natural size, showing the manner in which the septa are continued to the centre, and showing the arched ascending dissepiments, but having the other dissepiments omitted. B, vertical section of *H. Halli*, showing the central tabulate area, and both the ascending and descending series of dissepiments. C, cross section of *Crepidophyllum subcaespitosum*, the descending series of dissepiments being, as before, omitted: twice the natural size. D and E, cross sections of the same species, of the natural size. (D shows the central tabulate area completely closed in by the central tube ; and E exhibits the cut edges of some of the delicate descending series of dissepiments.) F, vertical section of a fragment of the same species, twice the natural size, showing the central tabulate area, with its enveloping wall, and the ascending and descending sets of dissepiments. B is slightly generalized, and some details have been omitted. All the specimens are from the Hamilton group of the State of New York and of Ontario.

The internal structure of the corallum in *Heliophyllum* is somewhat complex, but is rendered readily intelligible by means of transverse and longitudinal sections. The tabulæ

are seen in longitudinal sections (fig. B) occupying a central area of variable width. As a rule the tabulate area is of comparatively small extent, and the tabulæ are somewhat remote and irregular; but sometimes these structures occupy a considerable space, and are arranged with considerable regularity and close together.

The septa (fig. A) are always very well developed; and both primary and secondary septa are invariably present, so far as I have observed. All the primary septa extend to the immediate vicinity of the centre of the visceral chamber; but a large number of them, sometimes all of them, stop short of the actual centre. They all, however, become more or less flexuous as they approach the centre; and, as a general rule, a certain proportion of them continue inwards till they become connected in a loose and irregular network, though they in no case form a central cellular mass. Nor is there, under any circumstances, any true columella. The secondary septa, again, are very well developed, and usually extend to at least half, or even two thirds, of the length of the primary septa. Lastly, both the primary and secondary septa exhibit in cross sections a variable number of conspicuous cross bars (fig. A), which give to them an exceedingly characteristic appearance, though this cannot be regarded as peculiar to the genus. These cross bars are confined to the exterior portions of the septa, and are wanting centrally. They are formed by the transverse section of the ascending dissepiments; and as they run directly across the septa, it is evident that the dissepiments are placed at corresponding points on the two sides of each septum. In no case, however, do the cross bars formed in this way extend from one septum to those directly contiguous to it, but they are always confined to their proper septum; and they do not correspond in position in neighbouring septa.

The most characteristic features in the structure of *Heliophyllum* are due to the very remarkable form and arrangement of the dissepiments—an arrangement which has been (but erroneously) supposed to be peculiar to this genus. There are two groups or orders of dissepiments (fig. B), which intersect one another nearly at right angles, those of the one series having an ascending direction as regards the corallum, whilst those of the other are descending. The dissepiments of the ascending series form a group of strong curved ridges, directed in an arched manner upwards and inwards from the wall towards the centre, with the convexities of the arches upwards. When seen in longitudinal sections, they are never continuous from the wall to the free edges of the septa, but they

appear as successive rows of discontinuous ridges. Nor do they ever extend so far from any one septum as actually to reach the septa immediately contiguous to it. On the contrary, they occur in reality as so many strong ridges which are developed on the sides of each septum, and always in precisely corresponding positions on the two sides of any given septum. Hence it is that they appear in the calice as so many spines on the free edges of the septa, and in cross sections as so many cross bars intersecting the septa. Hence, also, in silicified specimens, in which the interior is exposed, they appear as curved striæ or ridges on the otherwise plain sides of the septa; and this appearance is not due to any disappearance or destruction of the dissepiments subsequent to the death of the polype, but is really due to the inherent form of these structures.

The dissepiments of the second order are exceedingly delicate, and are much less marked than those of the preceding series, which they intersect approximately at right angles. They are directed inwards and downwards, from the wall to the centre of the visceral chamber, and they are continuous between contiguous septa. They form a series of lenticular vesicles, which are seen in longitudinal sections (fig. B) to be arranged in oblique rows, directed inwards and downwards, with their convexities upwards. The extent to which they are developed, however, varies greatly in different cases; and though they are always preeminently developed in the outer portions of the corallum, they are never present in such numbers as to give rise to the conspicuous exterior zone of vesicular tissue which forms such a marked feature in corals such as the typical *Cyathophylla*.

The genus *Heliophyllum* owes its name to the eminent American palæontologist, Prof. James Hall; but its first publication was in Dana's great work on the corals (*op. jam cit.*). It was originally regarded as nothing more than a subgenus of *Cyathophyllum*; and no higher rank is assigned to it by Dana than this. In reality, however, it cannot be placed even in the immediate vicinity of *Cyathophyllum* proper, with which it has hardly any characters in common. Though this constitutes the first published description of the genus, it had been figured previously to this date, as the *Strombodes helianthoides* of Phillips ('Palæozoic Fossils,' pl. v. fig. 13, 1841) appears to be undoubtedly a species of *Heliophyllum*.

The first description giving any thing like a really accurate conception of the structure of the corallum in the genus *Heliophyllum* is that published by Milne-Edwards and Haime (Pol. Foss. des Terr. Pal. p. 408). They define the genus as

follows:—"Corallum simple, subturbinate. Septa well developed, and giving origin laterally to lamellar prolongations, which are directed from the wall towards the centre, in an ascending and arched direction, so as to constitute irregular tabulæ in the central area. These lamellar prolongations are united circumferentially by vertical plates." This definition, however, is not only deficient in its details, but it is erroneous in the important point that the tabulæ of the central area are considered as formed by prolongations from the ascending dissepiments, whereas these structures, in reality, are wholly independent of one another.

By Mr. Billings (Can. Journ. new ser. vol. iv. p. 124) the genus *Heliophyllum* is defined as follows:—"Corallum simple or aggregate; radiating septa well developed, obliquely striated on their sides by thin elevated ridges, which extend from the outer wall towards the centre. These ridges are connected by numerous thin laminae which divide the spaces between the septa into small sublenticular cells. The transverse diaphragms are thin, flexuous, and confined to the central portion of the coral." This definition likewise omits many characters of importance; and the distinguished Canadian palæontologist is certainly in error in concluding that "the only difference between this genus and *Cyathophyllum* is the absence of the curved striae from the septa of the latter."

By Dybowski (Mon. der Zoanth. scler. rug. aus der Silurformation &c. p. 83) the genus *Heliophyllum* is placed in a special family, Craspedophyllidæ, along with the two new genera *Acanthophyllum* and *Craspedophyllum*, the only characters assigned to the family being that there is no accessory wall, that the septa are complete, and that the sides of the septa are furnished with lateral outgrowths. As all these characters, however, might be predicated of other genera, it will hardly be possible to retain this family as it is at present constituted. Finally, a description of the generic characters of *Heliophyllum*, drawn chiefly from the beautiful silicified specimens of the Corniferous Limestone of North America, was published by the present writer ('Rep. on the Palæontology of Ontario,' part i. p. 24, 1874).

As regards the affinities of the genus *Heliophyllum*, it is certainly related to *Cyathophyllum*; but the differences between these two genera are so many and so great that it cannot be said that the relationship is by any means a very close one. If we confine our attention to the simple and more typical members of the genus *Cyathophyllum*, the chief points of relationship with *Heliophyllum* are to be found in the presence of an external vesicular area in both groups, in the

restriction of the tabulæ to a comparatively limited central zone, and to the fact that a certain number of the septa pass inwards to the centre, where they become more or less twisted together. Even in these points, however, the agreement is far from complete. In *Cyathophyllum* the exterior zone of vesicular tissue is invariably present, is largely developed, and is composed of very numerous minute cells; in *Heliophyllum* this zone is never largely developed, is sometimes altogether wanting, and is always composed of comparatively large cells, so as never to constitute a really conspicuous feature. Again, in the typical *Cyathophylla* the primary septa extend inwards to the centre, where they are twisted together so as to form a sort of spurious columella; in *Heliophyllum*, on the other hand, it is never more than a comparatively limited number of the primary septa which are continued inwards to the centre of the visceral chamber, and these, instead of becoming twisted together, unite with one another to form a loose and irregular network. When, however, we come to examine the differences between these two genera, they are found to materially outweigh the points of similarity. The species of *Heliophyllum* are, more particularly, fundamentally distinguished from those of *Cyathophyllum* by the presence of the peculiar arched lamellæ which are directed inwards and upwards along the sides of the septa, appearing on the free edges of the septa within the calice as so many teeth or spines, and constituting the characteristic cross bars by which the septa are seen in transverse sections to be intersected at regular intervals. No structure in any way capable of confusion with this has ever been detected in any *Cyathophyllum*.

Lindström has suggested that *Palæocyclus*, E. & H., will probably be found to be allied to *Heliophyllum*; but I am unable to confirm this suggestion. The free edges of the septa in *Palæocyclus* are denticulated in a manner superficially similar to what is seen in *Heliophyllum*; but vertical and transverse sections show that this denticulation is produced in a different way. At the same time the form of the corallum in *Palæocyclus* is quite unlike that of *Heliophyllum*, and the discoid forms are wholly destitute of tabulæ.

The nearest ally to *Heliophyllum* is undoubtedly the genus *Crepidophyllum*. In this genus we find the central tabulate area of *Heliophyllum* and the same scantily developed external vesicular area; whilst the free edges of the septa are rendered denticulate, and their transverse section is cross-barred by the same series of strong lateral arched lamellæ. In many respects, therefore, we find a complete resemblance between *Heliophyllum* and *Crepidophyllum*. At the same time the

latter is distinguished fundamentally by the fact that the central portion of the tabulate area is enclosed by a distinct and separate wall, with which the primary septa become directly connected, the central space thus enclosed usually opening at one point to form a wide fossette bounded by two primary septa and containing two or three short septa.

There is also a close relationship between *Heliophyllum* and *Phillipsastræa*, E. & H. The edges of the septa are occasionally denticulated in the latter genus in a manner apparently similar to that which obtains in *Heliophyllum*; and there is also a small central tabulate area. How far this resemblance is really founded upon identity of structure, I am not at this moment in a position to determine. At any rate, the genus *Phillipsastræa* is readily distinguished from *Heliophyllum* by the fact that the corallites of the former are wholly destitute of a proper wall, and become united by the confluence of septo-costal radii.

It may be mentioned, finally, that there are some species at present referred to *Acervularia* (such as *A. profunda*, Hall, and *A. Davidsoni*, E. & H., both from the Devonian formation) in which the edges of the septa are denticulated, and their transverse section cross-banded, as in the genus *Heliophyllum*. The more intimate structure of these forms, however, still awaits elucidation.

So far as at present known, the genus *Heliophyllum* is exclusively restricted in its range to the Devonian formation, being known to occur in both the New and the Old World at this horizon.

CREPIDOPHYLLUM, Nich. & Thomson.

Crepidophyllum, Nicholson and Thompson, Proc. Roy. Soc. Edinb. vol. ix. no. 95, p. 149.

Corallum simple or compound—in the former case cylindrical or cono-cylindrical, in the latter case forming large fasciculate masses. Increase by lateral gemmation in the compound species. Epitheca complete, thin, with encircling striæ and conspicuous annulations of growth. Tabulæ not complete, but confined to a more or less extensively developed central area, the median portion of which is enveloped in a distinct accessory wall, and thus shut off from the rest. The median tabulate tube (fig. C) thus formed may be completely enclosed; but more commonly it is open at one point, and the two extremities of the horseshoe thus formed become directly continuous with two of the primary septa, which in this way include a wide septal fossula, within which are contained two or three short septa. The remainder of the primary septa are well

developed, and extend from the epitheca to the accessory wall surrounding the central tube, with which they become directly connected. The primary septa never, however, extend into the interior of the central tube; and they alternate with well-developed secondary septa of more than half their own length. The calice is moderately deep, and exhibits at its bottom a small flat space formed by the upper end of the central tabulate tube. The free edges of the septa within the calice are denticulated; and the cross section of the septa shows them to be intersected by conspicuous cross bars, these appearances being produced by a series of strong arched lamellar dissepiments, which are developed at corresponding points on the two sides of each septum, and are directed upwards and inwards towards the centre. There is also a second series of more delicate dissepiments, which connect the septa with one another, are directed downwards and inwards, and give rise in longitudinal sections to a larger or smaller amount of exterior vesicular tissue.

It will be seen from the above description, that in many respects there is a very close relationship between *Crepidophyllum* and *Heliophyllum*. This is especially seen in the structure of the endothecal dissepiments, which are precisely the same in the two genera. In both we have a double series of dissepiments (figs. B & F), which intersect one another at high angles, those of the first series running upwards and inwards, and those of the second series running downwards and inwards. In both, the dissepiments of the first series are so far peculiar that they do not actually connect contiguous septa, but have the form of strong curved or arched ridges, which are developed on the sides of the septa and at precisely corresponding points on the opposite sides of each individual septum. Hence in both genera the dissepiments of this series give rise to three very characteristic and peculiar appearances: (1) the free edges of the septa in the calice are marked with blunt spines or teeth; (2) the sides of the septa, as seen in longitudinally fractured specimens, exhibit a series of pronounced striæ or ridges, directed upwards and inwards in an arched manner, with their convexities upwards; and (3) the cross section of the septa, both primary and secondary, shows them to be intersected by conspicuous cross bars. In both *Crepidophyllum* and *Heliophyllum*, again, we find a second series of dissepiments, which are much more delicate in structure, and are directed approximately inwards and downwards, and which actually connect contiguous septa with one another. These dissepiments are seen, in longitudinal sections, to form a series of comparatively large-sized vesicles,

which are strongly arched and have their convexities directed upwards. Though most largely developed in the external parts of the coral, the vesicles formed by the dissepiments of this series are variable in amount, and can hardly be said to constitute a distinct exterior vesicular zone, such as is so characteristic of the true *Cyathophylla*.

With these remarkable points of agreement we find the following equally remarkable points of divergence, by which *Crepidophyllum* is distinguished not only from *Heliophyllum*, but from all other known genera of the Rugose Corals:—(1) The central tabulate area, in most respects, closely resembles that of *Heliophyllum*, the tabulæ being remote, often more or less arched, and sometimes uniting with one another. The central portion of this area, however, is shut off from the rest of the visceral chamber by a secondary investment or accessory wall, so that there is constituted a kind of central pipe or tube (fig. F), which is crossed by the tabulæ, and runs down the centre of the corallum. (2) The central tabulate tube thus constituted, however, is only rarely quite complete: usually it is open on one side, and its investment or wall becomes continuous at this opening with two of the primary septa, which run to the margin of the corallum. (3) By means of these two primary septa and the secondary wall there is thus enclosed a large, somewhat horseshoe-shaped septal fossula (fig. C), within which are contained two or, more commonly, three short septa. (4) The remaining primary septa are continued inwards till they meet the wall of the central tube, with which they become coalescent. They do not, however, extend into the interior of the tube; and there is therefore no similarity between their arrangement and that which obtains in *Heliophyllum*, where a certain number of the primary septa pass inwards to the centre of the visceral chamber, and become loosely connected with one another there. Indeed I am not acquainted with any genus in which any close approximation to the peculiar structure of the central portion of the corallum in *Crepidophyllum* can be found. There is no other recorded genus in which the median portion of the central tabulate area is partitioned off by a distinct wall, with which all the primary septa are connected directly, and in which they terminate.

The genus *Crepidophyllum* contains two species of corals from the Hamilton formation (Devonian) of North America. One of these corresponds with a portion of the group of forms which I formerly described under the name of *Heliophyllum subcæspitosum* (Geol. Mag. new ser. dec. ii. vol. i. p. 58, pl. iv. fig. 9); and as it comprises the most typical members

of this group, it must now be known under the name of *Crepidophyllum subcaespitosum*. The remaining forms originally included under the title of *H. subcaespitosum* are really referable to *Heliophyllum*, of which they constitute a separate species (*H. elegantulum*, Nich. & Thomson). The other form of *Crepidophyllum* is the large compound coral which was originally described by Mr. Billings under the name of *Diphyphyllum Archiaci*, but which turns out on microscopic examination to be unquestionably a species of *Crepidophyllum*.

VII.—On Two New and remarkable Species of Cliona.

By W. J. SOLLAS, M.A., F.G.S., &c.

[Plates I. & II.]

1. *Cliona mucronata* (mihi).

(Examined in the dried state.)

Sponge occupying a number of chambers excavated in the solid calcareous base of a species of *Isis*.

Chambers of various forms, oval, spherical, or irregular, joined together in a single series or in more complex groups by constricted apertures or by narrow stolon-like tubes, each of which is usually furnished with a spicular diaphragm.

Spicules of three kinds:—1, a straight acuate (Pl. II. figs. 1–3), having a cylindrical shaft, which terminates at one end in a more or less spherical head and at the other is rounded off bluntly and then produced axially into a short sharp spine or mucrone; average length 0.004 inch, breadth across the head and rounded end 0.0006, and across the neck 0.0004, mucrone about 0.0002 inch long. 2, a slender pin-like acuate (Pl. II. figs. 6, 7), straight or curved, with a more or less spherical head and a sharp point; length 0.0073 inch, breadth across the head 0.0004, across the shaft 0.0002. 3, a minute or flesh-spicule (Pl. II. fig. 9), body spirali-sinuously curved once or oftener, or straight, irregularly spined; length 0.0006 inch.

Diaphragms irregularly disciform (Pl. I. figs. 2, 3, 6), conical (figs. 5, 9), or tubular (figs. 4, 10) and open at both ends; when conical, perforated by the truncation of the apex (fig. 5) or imperforate (fig. 9); circumferential edge of disk-like forms, or the base in the case of the other two forms, attached to the walls of the containing tube or constricted aperture, across which the diaphragm extends transversely. Composed chiefly